Farnell

"B SERIES"
STABILISED POWER SUPPLY UNITS

INSTRUCTION BOOK

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FARNELL INSTRUMENTS LIMITED

INSTRUCTION MANUAL

"B SERIES"
STABILISED POWER SUPPLY UNITS

ISSUE 1

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CONTENTS

SECTION I

INTRODUCTION

This manual covers the range of sub bench units B.30/2, B.30/5, B.30/10 and B.30/20. The circuit diagram contained in the manual is for the particular unit type supplied.

The "B" Series of stabilised power supply units consists of four single output, variable, D.C. supplies in sub-unit form. The semiconductor complement of these supplies is silicon throughout.

The output voltage of each unit is varied by a coarse switched control, and a fine control which allows continuous variation over each switched range.

Overload protection is provided by current limiting circuitry, which reduces the output current on short circuit on all ranges except the lowest, which keeps the output current roughly constant on overload. The output voltage automatically resets when the overload is removed.

Cooling is by air convection so that provision should be made to allow air to flow freely into the bottom, and out of the top of the unit.

The instruments operate from 50/400 Hz. mains supplies of 105, 110, 115V. or 210, 220, 230, 240V. by simple tap change on the transformer primary. Mains input is applied via the cable provided, and the D.C. output is drawn from terminals on the opposite side of the unit. Mains input and line fuses are fitted as additional protection.

SECTION II

OPERATION

Connection to the mains supply is via the three core cable provided. Due to new standards in mains cable colour coding' either of two types may be supplied, the coding being as follows :—

(i) Red—Live
Black—Neutral
Green—Earth.

(ii) Brown—Live
Blue—Neutral
Green and Yellow—Earth.

Units are normally supplied for 240V. operation, for other input voltages, see the note on transformer connections (fig. 1).

D.C. output is taken from the terminals on the front panel of the instrument. Feedback terminals are provided to correct for the voltage drop along the connecting leads. Connections should be made from the remote end of the negative lead to the connection marked F/B—, and similarly from the remote end of the positive lead to the F/B+ connection. (See note on Remote Sensing in Section VI). Where feedback connections are not required, output and appropriate feedback terminals should be linked at the terminals.

The current limit point is preset at the factory to approximately 10% in excess of the stated maximum operating current. Should this require adjustment, reference should be made to the note in Section V headed "current limit setting."

SECTION III

CIRCUIT DESCRIPTION

The circuit employs series regulator transistors driven via emitter followers from a differential amplifier, which compares the voltage of a zener diode reference with a proportion of the output voltage driven from a resistive potential divider.

The mains supply is connected via fuse F1 and S1 to MT. The main secondary winding supplies a bridge rectifier, reservoir capacitor system via S2a providing the main unregulated D.C. line. The positive line is connected via the series regulator transistors to the positive output terminal. The negative line is connected via fuse F2 to the negative output terminal.

Supplies for the amplifier and reference section are derived from the auxilliary 36 volt secondary winding via diodes D1 and D2, and smoothed by capacitor C1. VT1 and VT2 comprise a differential amplifier. The base of VT1 is connected to the feedback positive terminal. The base of VT2 is connected to a potential divider connected between the feedback negative terminal and the positive of reference zener diode Z3. Any difference between the two bases is amplified at VT2 collector and fed to VT3 base. This is again amplified at VT3 collector and applied to the driver stages in such a sense as to oppose the original difference. The action of the loop is therefore to maintain zero difference between VT1 and VT2 bases.

Overload protection is provided by differential amplifier VT4 and VT5. The base of VT4 is connected to the positive output, and the base of VT5 is connected to a potential divider (i) on the lowest range, T2, R16 connected between the series regulator emitter and the negative of the auxilliary line. (ii) on the other ranges, T2, P1a, R17, R18, R19, R20 connected between the series regulator emitter and negative feedback terminal.

(i). When output is low VT5 is non-conducting since its base is negative with respect to VT4 base. As output current increases, the voltage across R31 increases and the junction of R31 and T2 becomes more positive causing VT5 to conduct. This by-passes some of the current from VT6 base, and the output starts to fall. On further increase in load, VT5 will maintain a constant voltage drop across R31, which gives a constant current output. The point at which the initial current limit occurs is set by T2.

(ii) As output current increases, the voltage across R31 increases, and the junction of R31 and T1 becomes more positive causing VT5 to conduct. This by-passes some of the current from VT6 base, and the output voltage starts to fall. As the output falls, the base of VT5 becomes more positive due to the action of potential divider T2, P1a, R17, R18, R19, R20.

This causes VT5 to conduct more and the output voltage falls further. In the absence of R12, this process would be regenerative i.e. as soon as the limit point was reached, the output voltage would fall immediately to zero. R12 increases the slope of the output V/I characteristic in overload to produce the overload characteristic shown in Fig. 5. With increasing overload the action of the circuitry is to reduce output current until at short circuit the current is approximately 10% of the maximum output current. This ensures that the unit will reset into normal loads, once the overload is removed. The point at which initial current limit occurs is set by T2.

SECTION IV

SPECIFICATION

Mains Input

Standard—240V., 50/400Hz.

By internal link changes — 210, 220, 230V., 50/400Hz.
105, 110, 115V., 50/400Hz.

Output voltages and current ranges

Type	*Output Voltages*	*Output Current*
B.30/2	0 — 30V.	2A.
B.30/5	0 — 30V.	5A.
B.30/10	0 — 30V.	10A.
B.30/20	0 — 30V.	20A.

Input Variation Tolerated.

±10% of nominal.

Output Change for ±10% Mains Change.

Less than .01% or 1mV. whichever is the greater—short term.
Less than .02% or 2mV. whichever is the greater—long term.

Output change from zero to full load change.

Less than .01% or 1mV. whichever is the greater—short term.
Less than .02% or 2mV. whichever is the greater—long term.

Ripple voltage at full load.

Less than 1mV. peak to peak.

Overload protection.

Current limiting with reduction of output current on increasing overload on all but the bottom range which is current limiting only.

Maximum operating temperature.

50°C.

Temperature Coefficient.

±.02% per °C. typical.

Output impedance.

See Fig. 2.

SECTION V

INTERNAL ADJUSTMENT

Units are factory set to give the specified output voltage and current limit at approximately 10% in excess of the specified current output. In the event of future mis-alignment, the setting up procedure is as follows :—

Output Voltage Adjustment. With the range switch at its highest setting and the fine control turned fully clockwise, T1 on the circuit board is adjusted to give approximately 30.5 volts at the output.

Current Limit Setting. With the range switch at its highest setting, the fine control is adjusted to give 30 volts at the output. A variable load is connected to the output to take 10% in excess of the specified maximum output current, and T2 adjusted until the output voltage just starts to fall.

Input Voltage Adjustment. See Fig. 1.

SECTION VI

TYPICAL PERFORMANCE AND APPLICATIONS

TYPICAL PERFORMANCE.

Stability—Output Voltage variations are due, in the main, to the following causes :—

(a) Load Change.

(b) Mains Supply Change.

(c) Component temperature change.

(a) *Load Change.*

(i) Steady load—For a change in steady load from to full load, the typical worst case change is 800μV.

(ii) Transient Response—The typical response to a pulsed load is shown in fig. 3. This is measured with appropriate O/P and F/B terminals linked at the terminals (see note on Remote Sensing).

(iii) Output Impedance—For alternating load superimposed on a steady load, the output impedance of the supply increases with frequency, due to fall off in gain of the amplifier until it is determined only by the capacitor across the output terminals. A typical output impedance-frequency curve is shown in fig. 2. This again is measured with the appropriate O/P and F/B terminals linked at the terminals.

(b) *Mains Supply Change.*

Short term variations of up to $\pm 10\%$ give corresponding variation of .02% on the output. Surges on the mains supply in the form of short rise time pulses can be fed to the output by stray capacity. Where these conditions exist, a capacitor suppressor filter should be connected in the mains lead.

(c) *Component Temperature Change.*

Output variation is caused by component value changes due to temperature change. The temperature change can be (i) as a result of ambient change or (ii) as a result of unit internal temperature change, caused by changing internal dissipation from a change in load or supply to the unit. (i) Ambient change—The typical temperature coefficient of output voltage is .02% per degree centigrade of ambient change.

(ii) Internal Change—Figure 4 shows typical output variations caused by mains change and load change, plotted against time.

Overload Protection.

Typical output voltage/current curves are shown in fig. 5. The position of the current limit once set will remain typically within 5% of the setting over the temperature range 0—50°C.

Applications

Parallel Operation. Units which are set to approximately the same output voltage may be connected directly in parallel. By increasing load, the unit having the highest output voltage will carry the load until it current limits, thereafter the unit having the next highest voltage will supply the extra current until it limits, and so on. A typical output characteristic for a parallel combination of three units is shown on Fig. 5. The characteristic shows a series of descending steps in output voltage at the current limit points of individual units, the amplitude of the step depends on how closely the output voltages have been set and it may not be possible to adjust this to better than 50mV.

It is recommended that not more than three units are paralleled in this way.

Series Operation. Units may be connected in series but on switch on or overload, it may be found necessary to disconnect the load momentarily in order that the series combination will operate correctly on all ranges except the lowest. This is due to the nature of the current limit circuitry. The effect may be overcome by lowering the value of R12. This also increases the current capability of the unit with a short circuit connected to it.

The percentage of maximum output current capable of being delivered into a short circuit is given approximately by :—

$$\% \text{ I max.} = \frac{5 + T2 + 100}{R12}$$

Where T2 and R12 are in Kilohms.

WARNING—R12 Must not be made less than 9K. as over-dissipation will occur under sustained short circuit conditions.

Remote Sensing—Feedback terminals are provided to correct for voltage drop along connecting leads, to a remote load. Connections should be made from the remote end of the negative lead to the connection marked F/B—, and similarly from the remote end of the positive lead to the F/B$\pm$ connection.

Phase shifts will be introduced into the feedback loop of the amplifier due to inductance in the output leads, which may cause instability. There are several methods of combating this problem.

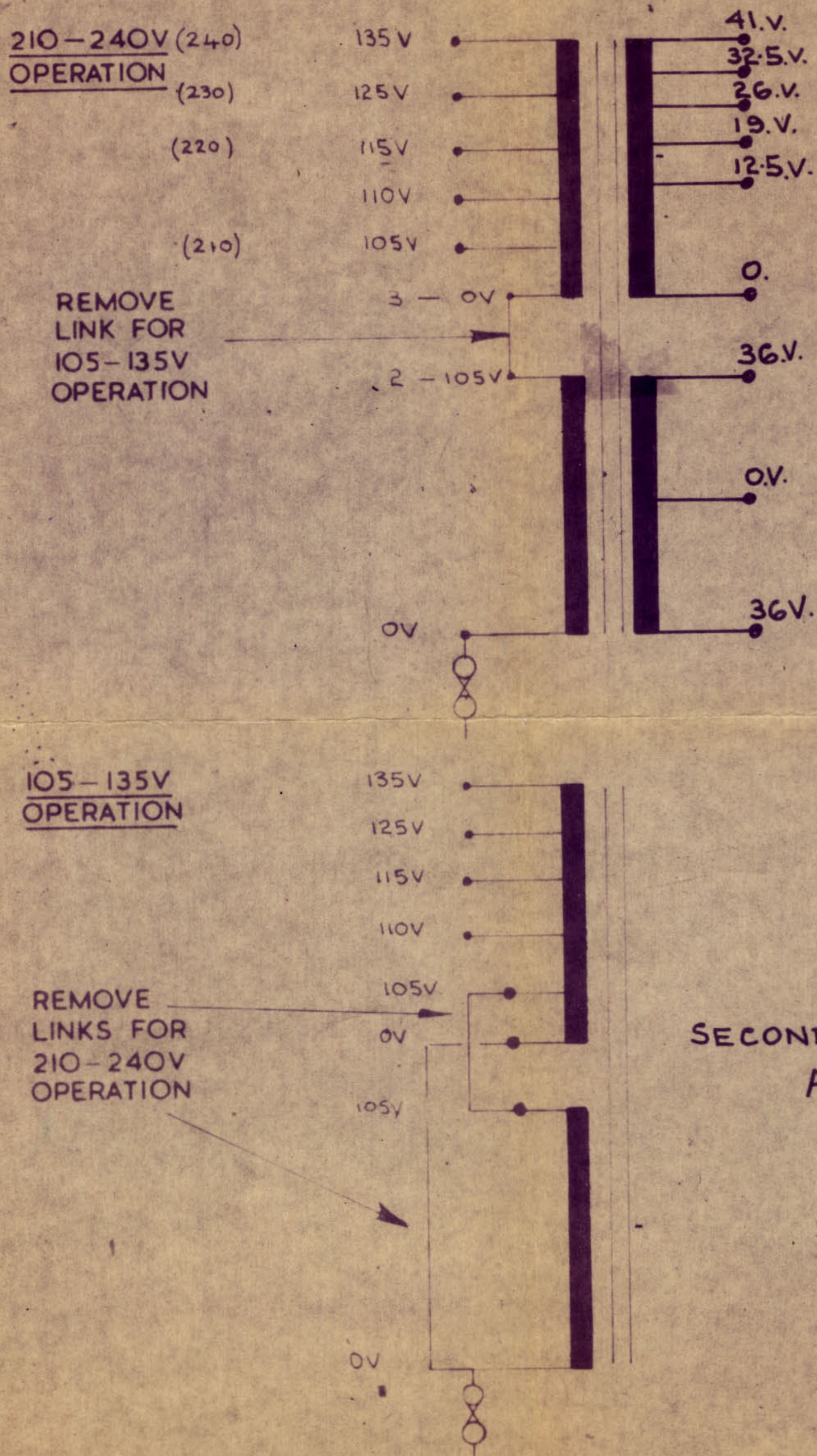
Ideally the output current should be fed along the screen of a screened cable, whilst the appropriate feedback terminal is connected to the load via the centre core. This provides distributed coupling between output and feedback leads.

If this proves to be impractical, the respective output and feedback leads should be twisted together, and electrolytic capacitors fitted across the respective output and feedback terminals. The values of these capacitors must be determined experimentally as they depend upon the particular installation.

An electrolytic capacitor should be connected across the load, at the remote end of the leads of the order of 2,000 microfarads, as this reduces overshoot on pulsed loads under these conditions.

TRANSFORMER CONNECTIONS

B 30/2
B 30/5
B 30/10
B30/20



SECONDARY WINDINGS
AS ABOVE

4-3606.

FIG. 1.

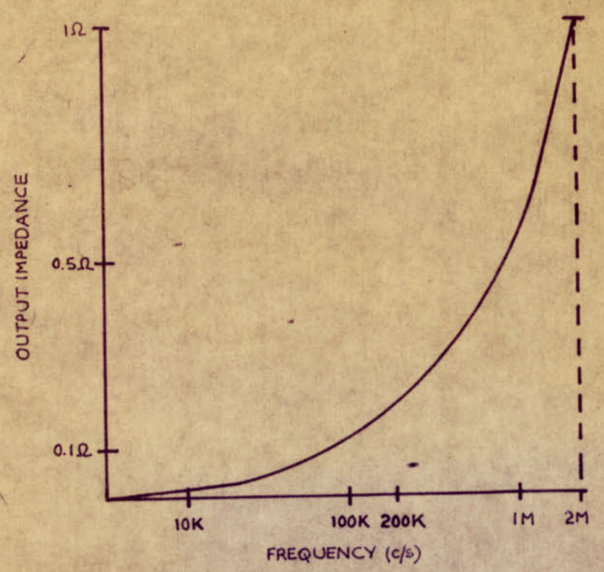


Fig 2. Output Impedance

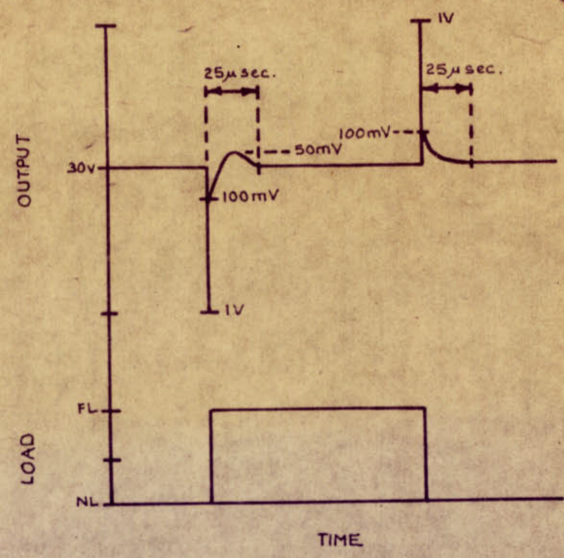


Fig 3. Pulse Response

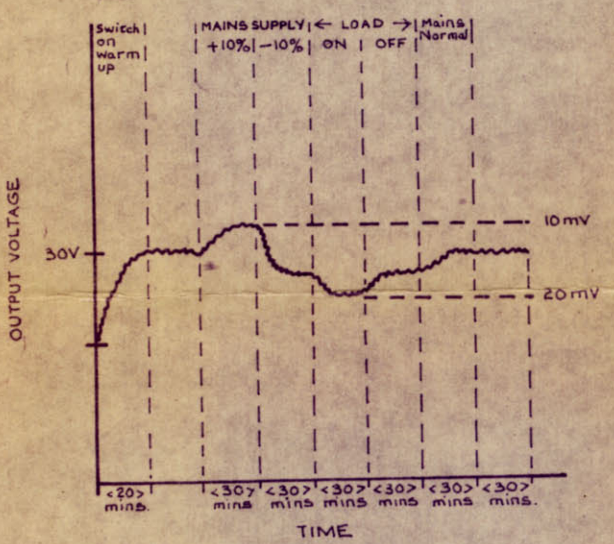


Fig 4. Typical Output Voltage Variation against Time.

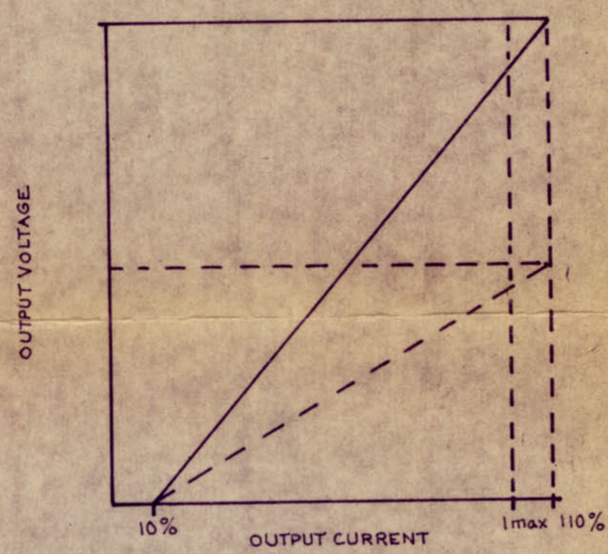


Fig 5. Output Protection.

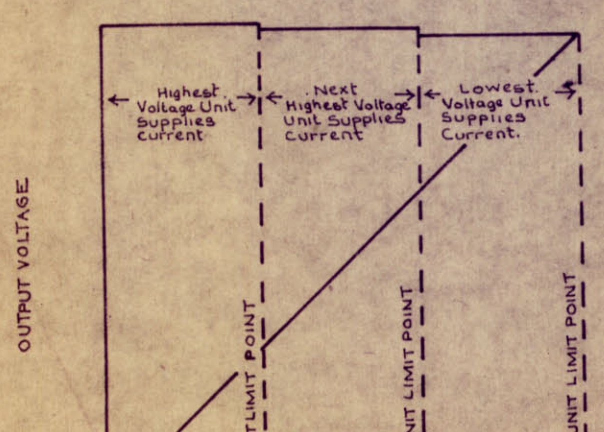
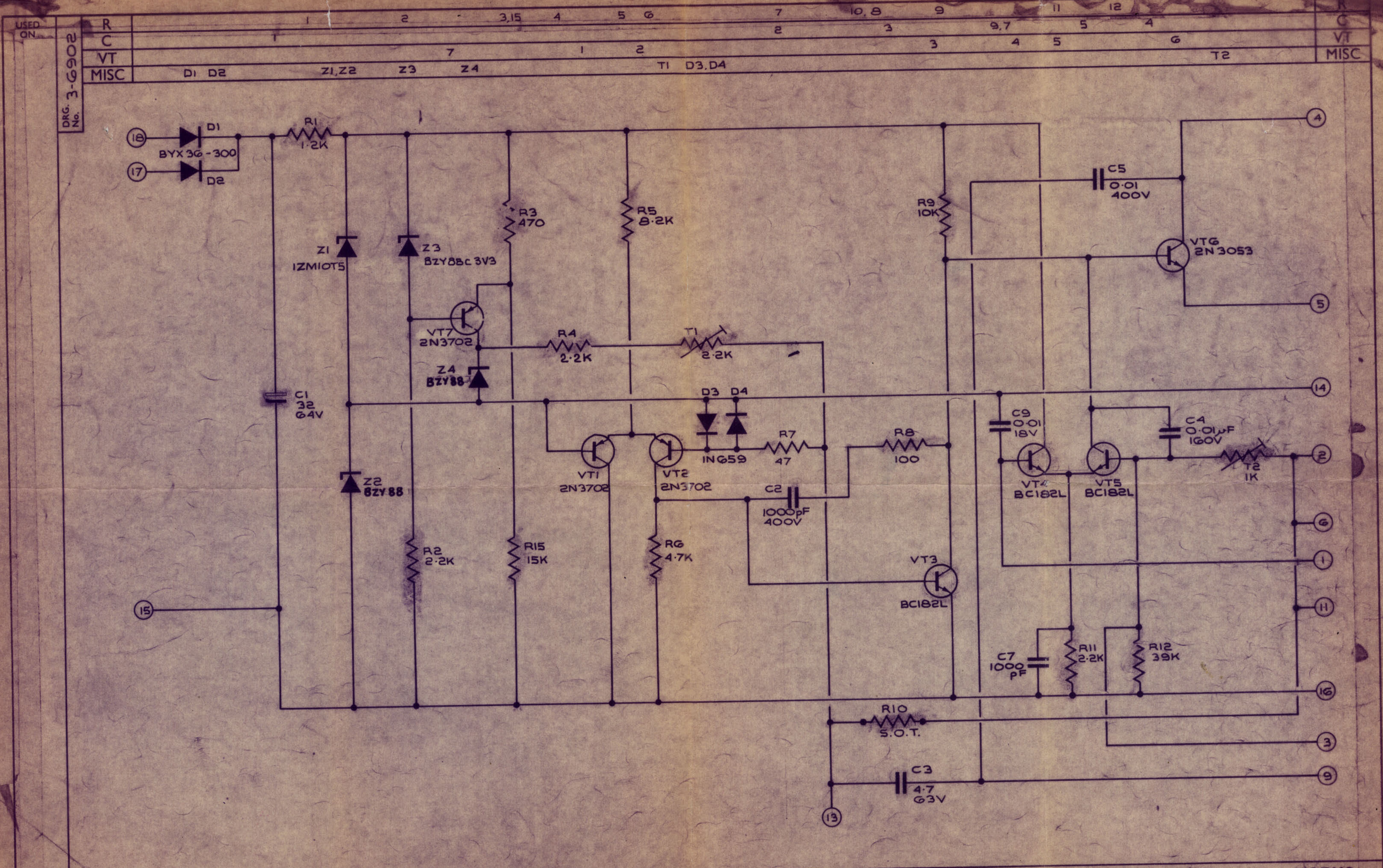


Fig 6. Parallel Operation

FIGS 2-6

4-3604



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NOTE :—
CAPACITOR VALUES GIVEN IN µF.
RESISTOR VALUES IN Ω
(2) REFERS TO CCT. BD. PIN CONNECTION Nos.

FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.

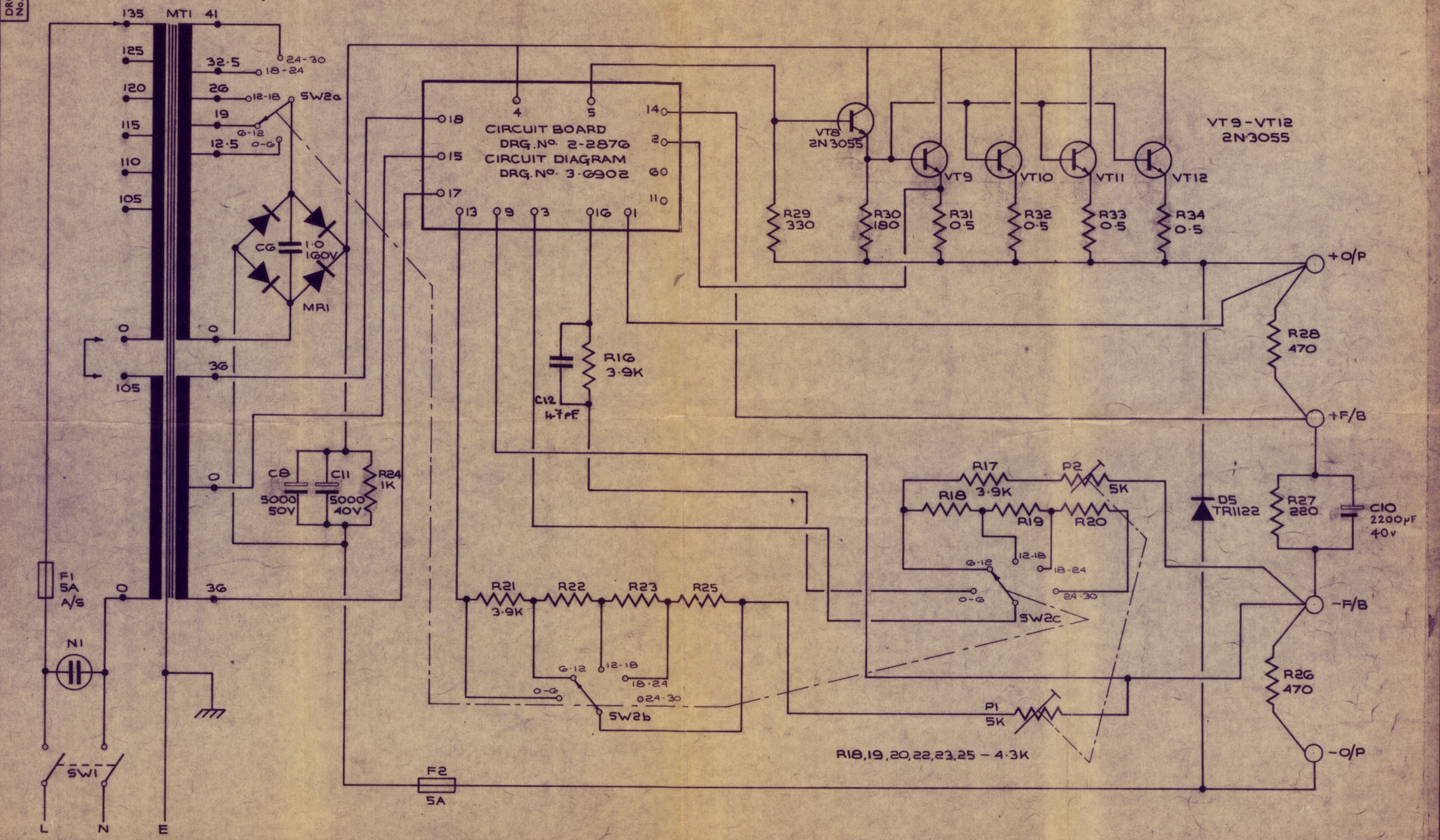
CIRCUIT DIAGRAM
CIRCUIT BOARD
B30 RANGE

DRAWING No.
3-6902

USED ON

DRG. No. 3-6899

R	24 21,22,23,25 16 29 30-34 18,17,19 20 28,27,26
C	6 8 11 12 10
VT	8 9 10 11 12
MISC	F1 N1 SW1 MR1 SW2a F2 SW2b P1 SW2c P2 D5



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NOTE :–
CAPACITOR VALUES GIVEN IN μF.
RESISTOR VALUES IN Ω
(2) REFERS TO CCT. BD, PIN CONNECTION Nos.

FARNELL INSTRUMENTS LTD. WETHERBY, YORKS.

CIRCUIT DIAGRAM

B30/5

DRAWING No.
3-6899

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